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THE COMBINATIVE CAPACITY OF HYBRIDS FROM CROSSBREEDING LINES AT THE SILKWORMS BREED BANEASA 75 (*Bombyx mori* L.)

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Abstract

The results of former research concerning the development of inbred lines in native silkworms breeds, established the technologic formation procedures and pointed out reduced values of inbreeding depression in the productive characteristics. The object of the present research aims are the identification and selection of the most productive inbred lines based on crossing with tester constant lines, namely the research of general combining capacity; establishing specific combining capacity by direct and reciprocal crossing and estimation of heterosis effect. The results of research emphasize that from those 14 inbreeding lines tested for combining capacity, 7 and 10 maternal lines and 3 paternal lines obtain heterosis results that demonstrate superior possibilities of turning into account the crossbreeding system in silkworms raising. The heterosis effect is obvious important foe shell weight.

Key words*: inbreeding; heterosis; tester constant lines*

INTRODUCTION

The formation and highlighting of inbreeding effects on morphofunctional traits in silkworms have constituted the first works for using artificial populations in capitalization of hybridization effects. The objectives of this research have the purposes: identifying and selection of the most productive inbreeding lines from the 14 lines formed in the frame of Băneasa 75 race on the basis of crossings with tester races (lines), respectively, the research of general combining capacity; finding specific combining capacity by direct and reciprocical crossings and the evaluation of the heterosis effect.

On the basis of the data from world specialty literature, the data of Romanian researches and experiments and our own researches, resulted that the quantitative and qualitative performances in silkworm change in positive sense from generation to generation and the substantial contribution of this progress is obtained by the maximum capitalization of genetic improvement theory and practice.

From this point of view, the hybridization of artificial populations obtained by management and supervision of formation and using inbred lines constitutes a foundation of currently scientific and practical concerns.

Without constituting a practice in silkworm breeding, in our country, the creation of inbred lines and their selection on the basis of general and specific combining capacity has been reported in some speciality papers: Craiciu and Otărăşanu,1969; Craiciu et al.,1970; Craiciu et al., 1971; Craiciu and Tiţescu, 1971a; Craiciu and Tiţescu, 1971b; Craiciu et al., 1974a; Craiciu et al., 1974b.

The selection of the most productive hybrid combinations on the basis of dialele crossings between pure races, also made the object of some researches in our country: Braslă et al., 1992; Matei et al., 2001; Matei et al., 2002a; Matei et al., 2002b.

Worldwide, the researches in which the heterosis is obtained by decomposition of populations into inbred lines, the selection between lines on the basis of general combining capacity and the obtaining of hybrids by crossing the lines with high specific combining capacity, are mentioned in the papers elaborated by: Kremky, 1983; Pershad et al., 1986; Datta and Pershad, 1988: Jeong et al., 1990; Nagaraja and Govindan, 1994; Ho Zoo Lea, 1998; Kalpana and Sreerama Reddy, 1998; Singh et al., 2001, Mirhosieni et al., 2004; Rahman et al., 2015.

Instead, the selection between the existent races, non-inbred, on the basis of their specific combining capacity tested in crossings with other populations, represents a current technique in sericiculture: Petkov N. şi col. (1984); Pershad G. D. (1986); Datta R. K. şi col. (1988); Lin Jianrong (1989); Xue-Weihua (1989); Jeong W. B. (1990); Jung D. S. (1990).

The final purpose of the silkworm improvement program is the increasing of silk production. The hybridization represents one of the ways to achieve this objective. However, choosing the lines used in hybridization is difficult, due to their different behaviours. Because of this, the actual achievement of the crossings is preceded by the selection between lines, related to the additive and non-additive The selection of additive variations relates to the appreciation of reproductives improvement value by their general combining capacity in different crossing couples.

The selection of non-additive variations refers to the specific combining capacity manifested in crossings between lines.

In this context, the experiences purpose in this stage consists in:

- identifying the most productive inbred lines in crossings with tester races (finding the general combining capacity of inbred lines in I_4);
- finding specific combining capacity by direct and reciprocical crossings between selected lines on the basis of general combining capacity and the evaluation of heterosis effect.

MATERIALS AND METHODS

In the present synthesis there are shown the results regarding two of the most important productivity traits in silkworm: the shell cocoon weight and the silk content; we mention that the traits studied in the whole paper have been 9, as an expression of the most works in this field.

The biological material has been constituted by 14 hybrid combinations between the inbred lines I_4 and the race considered content tester J90.

Samples size on which the determinations were made, was in the eggs stage of 500 eggs/experimental variant (hybrid) and in the larval stage for each hybrid were made 3 lots x 200 larvae/lot at the beginning of the third larval age.

In the stage of raw cocoon, the determinations were made on 100 cocoons, representing both sexes, and in the stage of dried cocoon and filament, on 50 cocoons/hybrid.

The work methods were those used in experimental sericicultural technique and have been grouped into three categories: those used in obtaining experimental data in egg, larva, cocoon stage; those used in larvae incubation and rearing; those used in finding general and specific combining capacity.

The inbred lines with high general and specific combining capacity have been selected and used in the obtaining of commercial hybrids.

RESULTS AND DISCUSSIONS

The performances of inbred lines in I_4.

In the assortment of analyzed lines have been included lines that differ by traits direct related to the cocoon production, as: raw cocoon weight, shell weight, silk cover.A classification of the inbred lines on the basis of average values of their traits in Băneasa 75 race is presented in Table 1.

From their analysis results that in the group of inbred lines from Băneasa 75 race, a number of 9 lines presents for shell weight values above lines average, highlighting 4 of them.

From the same table it is noted that the lines average for the silk percentage was 18.54%, a number of 11 lines presenting values above average.

Between the inbred lines that came from the founding race Băneasa 75 the following lines stood out: B 75 -12 line; B 75 -10 line; B 75 -14 line; B 75 -7 line.

The performances of combinations resulted from crossing the inbred lines with the tester race.

The combining capacity of inbred lines is one of the important operations of organization and realization of an interlinear hybridization program. Making a whole series of possible crossings between a high number of inbred lines, as the subsequent experimentation of the obtained hybrids assume great efforts and costs. From this reason, there have been elaborated procedures that allow a prior sorting of the lines on the basis of their value in crossings with an analyzer race (tester), following that the selection on the simple hybrids level to be made only between the combinations of the selected lines, much less in number.

The experimental material is represented bythe hybrid group with 14 direct simple combinations realized between 14 inbred lines in I_4extracted from Băneasa 75 race, which played the role of maternal genitor in the hybridization formula and the tester race J 90.

The general combining capacity has been directly appreciated by determination of the character value at the descendants resulted from hybrids creation.

The analysis of general combining capacity of the set of hybrids resulted from crossings between inbred lines and tester race gave the possibility of identifying a number of hybrid combinations with high values of parameters which were on the basis of their evaluation. The obtained results are shown in Table 2.

The shell cocoon weight varied between 0.304 – 0.221g, with a group average of 0.273 g. From the group of hybrids Băneasa 75 x Tester in which the silk content varied between 22.01 – 17.75% we noticed the hybrid combinations between Băneasa 75 L10 x J90, Băneasa 75 L12 x J90, Băneasa 75 L2 x J90.

The performances of hybrids resulted from direct and reciprocal crossing (specific combining capacity) between the lines selected on the basis of general combining capacity

The results of the researches concerning hybridization between inbred lines selected on the basis of general combining capacity are presented in Table 3.

A first conclusion resulting from the data's analysis is that the shell cocoon weight is medium to strong influenced by the heterosis effect, in positive sense, while the silk cover is negatively influenced by the heterosis effect.

Regarding the results of hybrid combinations in Băneasa 75 race, the shell weight presents positive effects in the case of all combinations of selected lines. The greatest heterosis effects for this character are recorded for the combinations in which the lines 10 and 7 are maternal forms and the other selected lines are paternal forms.

Table 1.Classification's order of inbreeding lines selected for crossbreeding with tester breed

Line	Shell weight (g)	Difference ± out of average	Line	Silk cover (%)	Difference ± out of average
I 12	0.304 ± 0.020	+ 0.050	L 10	22.01 ± 2.47	+ 3.47
I 10	0.303 ± 0.040	+ 0.049	L 12	21.34 ± 1.28	+ 2.80
I 14	0.294 ± 0.034	+ 0.040	L 2	20.88 ± 2.08	+ 2.34
I 7	0.287 ± 0.032	+ 0.033	L 14	20.82 ± 2.03	+ 2.28
I 2	0.286 ± 0.030	+ 0.032	L 7	20.60 ± 1.41	+ 2.06
I 13	0.284 ± 0.037	+ 0.030	L 5	20.45 ± 1.95	+ 1.91
I 5	0.283 ± 0.030	+ 0.024	L 4	20.01 ± 1.51	+ 1.47
I 2	0.282 ± 0.026	+ 0.028	L 13	19.90 ± 1.98	+ 1.36
I 6	0.279 ± 0.035	+ 0.025	L 6	19.67 ± 1.64	+ 1.13
I 8	0.250 ± 0.030	- 0.004	L 8	19.16 ± 1.39	+ 0.62
I 9	0.244 ± 0.026	- 0.010	L 11	18.68 ± 1.65	+ 0.14
I 11	0.241 ± 0.030	- 0.013	L 9	18.32 ± 1.50	- 0.22
I 15	0.221 ± 0.030	- 0.033	L 15	17.75 ± 1.98	- 0.79
X	0.254 ± 0.020		X	18.54 ± 1.87	

Table 2.Performances of combinations at the inbreeding lines (Băneasa 75) and tester breed

Inbreeding line x Tester	Shell weight (g)	Silk cover (%)
	$X \pm s_x$	$X \pm s_x$
I 1 x J 90	-	-
I 2 x J 90	0.286 ± 0.030	20.88 ± 2.08
I 4 x J 90	0.282 ± 0.026	20.01 ± 1.51
I 5 x J 90	0.283 ± 0.034	20.45 ± 1.95
I 8 x J 90	0.250 ± 0.030	19.16 ± 1.39
I 6 x J 90	0.279 ± 0.035	19.67 ± 1.64
I 7 x J 90	0.287 ± 0.032	20.60 ± 1.41
I 9 x J 90	0.244 ± 0.026	18.32 ± 1.50
I 10 x J 90	0.303 ± 0.040	22.01 ± 2.47
I 11 x J 90	0.241 ± 0.030	18.68 ± 1.65
I 12 x J 90	0.304 ± 0.020	21.34 ± 1.28
I 13 x J 90	0.284 ± 0.037	19.90 ± 1.98
I 14 x J 90	0.294 ± 0.034	20.82 ± 2.03
I 15 x J 90	0.221 ± 0.030	17.75 ± 1.98

Table 3. Performances of hybrids from direct and reciprocal crossing (specific combinative ability) between the selected lines on their general combinative ability in Băneasa 75 breed

Parents	Shell weight			Silk cover		
P_1 P_2	MP	F_1	H (%)	MP	F_1	H (%)
7 x 7	0.287	-	-	20.60	-	-
7 x 10	0.295	0.302	2.37	21.30	22.03	3.42
7 x 12	0.295	0.323	9.49	20.97	21.89	4.38
7 x 14	0.290	0.362	24.82	20.71	21.36	3.13
10 x 10	0.303	-	-	22.01	-	-
10 x 7	0.295	0.323	9.49	21.30	22.29	4.64
10 x 12	0.303	0.342	12.87	21.67	19.77	- 8.76
10 x 4	0.298	0.344	15.43	21.41	21.24	- 0.79
12 x 12	0.304	-	-	21.34	-	-
12 x 7	0.295	0.308	4.40	20.97	19.79	- 5.62
12 x 10	0.303	0.335	10.56	21.67	20.60	- 4.93
12 x 14	0.299	0.304	1.67	21.08	19.70	- 6.54
14 x 14	0.294	-	-	20.82	-	-
14 x 7	0.290	0.310	6.89	20.71	19.40	- 6.32
14 x 10	0.298	0.319	7.04	21.41	20.44	- 4.53
14 x 16	0.299	0.308	3.01	21.08	20.36	- 3.41

Regarding the silk content, it is noted that the heterosis effect is generally low in value, in some cases insignificant, therefore absent, with negative values in most combinations and with positive, but small values, in the combinations of line 7 as maternal form and lines 10, 12, 14 as paternal forms.

Taking into consideration the two characters, results that the shell weight is a trait mainly controlled by genes with non-additive action, and therefore suitable for obtaining the heterosis effect, while the silk cover is generally controlled by additive genes.

CONCLUSIONS

The study of inbreeding and hybridization effects in silkwormwas materialized in completion of experiences on inbred lines behaviour under the report of general combining capacity and specific combining capacity, respectively of estimate the crossing and heterosis effects.

The selection of inbred lines on the basis of generalcombining capacity was done using the ranking on the basis of the results of their crossing with an analyzer race (constant tester), respectively J90 of Japonese provenance.

From the 14 hybrid combinations realized between the inbred lines and the tester race, were selected 4 inbred lines, taking as selection criterion the shell weight and the silk cover.

It results that about 30% of the formed inbred lines constitutes higher biological material in the obtaining of commercial hybrids.

The shell weight is medium to strong influenced by the heterosis effect, in positive sense, while the silk cover is less influenced by the hybrid vigour effect and in most cases in negative sense.

Taking into consideration the two characters based on which the evaluations were made, it results that the shell weight is a trait controlled in substantial proportion by non-additive genes with major action and so suitable for obtaining the heterosis effect, while the silk content is in generally controlled by additive genes.

The obtained results and the differences evaluated between various combinations highlight the possibility of parental from selection in order to obtain commercial hybrids.

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